

Appendix E

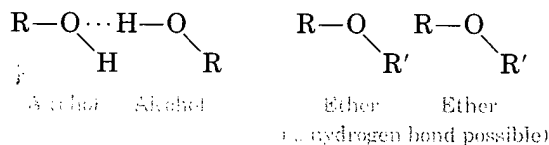
Table 12.3 Molecular Weights, Boiling Points, and Solubilities of Some Simple Alkanes, Alcohols, and Ethers

| Name | Structural Formula | MW | BP (°C) | Solubility in Water |
|---------------------|---|----|---------|---------------------|
| Ethane | $\text{CH}_3\text{—CH}_3$ | 30 | −88 | Insoluble |
| Methanol | $\text{CH}_3\text{—OH}$ | 32 | 65 | Soluble |
| Propane | $\text{CH}_3\text{—CH}_2\text{—CH}_3$ | 44 | −42 | Insoluble |
| Dimethyl ether | $\text{CH}_3\text{—O—CH}_3$ | 46 | −23 | Soluble |
| Ethanol | $\text{CH}_3\text{—CH}_2\text{—OH}$ | 46 | 78 | Soluble |
| Butane | $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_3$ | 58 | 0 | Insoluble |
| Ethyl methyl ether | $\text{CH}_3\text{—CH}_2\text{—O—CH}_3$ | 60 | 11 | Soluble |
| 1-Propanol | $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—OH}$ | 60 | 97 | Soluble |
| Ethylene glycol | $\text{HO—CH}_2\text{—CH}_2\text{—OH}$ | 62 | 198 | Soluble |
| Pentane | $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—CH}_3$ | 72 | 36 | Insoluble |
| Diethyl ether | $\text{CH}_3\text{—CH}_2\text{—O—CH}_2\text{—CH}_3$ | 74 | 35 | Slightly soluble |
| Methyl propyl ether | $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—O—CH}_3$ | 74 | 39 | Slightly soluble |
| 1-Butanol | $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—OH}$ | 74 | 117 | Slightly soluble |
| 1,3-Propanediol | $\text{HO—CH}_2\text{—CH}_2\text{—CH}_2\text{—OH}$ | 76 | 214 | Soluble |

Boiling Point

Ethers have about the same boiling points as alkanes of similar molecular weight. Thus, with respect to boiling points, ethers are essentially no different from hydrocarbons or halides.

This is not true for alcohols. The boiling points of alcohols are much higher than those of the corresponding alkane and ether, and those of the diols are much higher still. This is easily explained by hydrogen bonding. Each alcohol molecule can form a hydrogen bond with another one, but an ether molecule cannot:

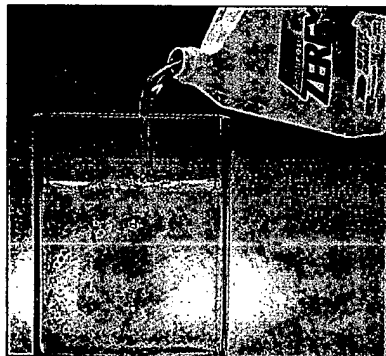


Alcohols have higher boiling points because hydrogen bonds must be broken during boiling, and this requires energy, available only at higher temperatures. Diols, with two —OH groups, have hydrogen bonds on two sides, so their boiling points are higher still. Hydrogen bonding also accounts for the viscosity of such liquids as ethylene glycol and glycerol.

Solubility in Water

A look at Table 12.3 shows that both alcohols and ethers are soluble in water, up to about three or four carbons. This behavior is, of course, completely different from that of the hydrocarbons and halides. Again, the

Review Section 6.6 for a discussion of which molecules can form hydrogen bonds.



Hydrogen bonding accounts for ethylene glycol's viscosity and its solubility in water. (Photograph by Charles D. Winters.)

reason is hydroxyl atom, so both

Alcohols and ethers are soluble in water because they can form hydrogen bonds. For example, 1-propanol (three carbons) forms hydrogen bonds with the alkyl portion of the water molecule. Because this is a small molecule, 1-heptanol

As you may know, alcohols like those of a

12.8 Thiols,

Thiols and thioethers, phenols, and ethers

but are much less soluble in water. Worth mentioning

1. Thiols have higher boiling points than alcohols of similar molecular weight because of the hydrogen bonding between the sulfur and hydrogen atoms. This is bad for chemical reactions involving the liquid squirted out of the nozzle.

2. Thiols are more soluble in water than alcohols of similar molecular weight.

3. Thiols are more soluble in water than alcohols of similar molecular weight.